

## INORGANIC NOMENCLATURE

Chemistry is a lot like living in a foreign country. If you speak the language, life is more fun! Learning inorganic nomenclature is the first step toward learning the language of chemistry. Learning the relationship between chemical formulas and chemical names is essential for understanding chemical problems. Inorganic nomenclature is a systematic way of naming the thousands of inorganic compounds we encounter.

Your textbook discusses nomenclature of inorganic compounds. This handout is intended to supplement and complement your book Chapter 7.

There are certain elements, cations, and anions that you **MUST** know before you get started. Position in the periodic table can help you remember many, but not all. For any name you should be able to write the formula and for any formula you should be able to write the name including spelling.

1. You should know the first 38 elements and Au, U, Ag, Sn, Hg, Cd, Sb, I, Xe, Cs, Ba, Rn, Ra, and Pb

2. Compounds with common names:

H <sub>2</sub> O	-	water
H <sub>2</sub> O <sub>2</sub>	-	hydrogen peroxide
NH <sub>3</sub>	-	ammonia

3. Cations

### Names

Lithium ion, sodium ion, etc.  
Beryllium ion, magnesium ion, etc.  
Hydronium ion  
Aluminum ion  
Iron(II), Iron(III)  
Copper(I), Copper(II)  
Silver ion  
Mercury(I), Mercury(II)  
Lead(II), Lead(IV)  
Ammonium ion  
Cadmium ion  
Zinc ion  
Nickel(II), Nickel(IV)  
Gold(I), Gold(III)  
Cobalt(II), Cobalt(III)  
Tin(II), Tin(IV)  
Chromium(II), Chromium(III)

### Symbols

Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Rb<sup>+</sup>, Cs<sup>+</sup>  
Be<sup>2+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup>, Sr<sup>2+</sup>, Ba<sup>2+</sup>  
H<sup>+</sup>  
Al<sup>3+</sup>  
Fe<sup>2+</sup>, Fe<sup>3+</sup>  
Cu<sup>+</sup>, Cu<sup>2+</sup>  
Ag<sup>+</sup>  
Hg<sub>2</sub><sup>2+</sup>, Hg<sup>2+</sup>  
Pb<sup>2+</sup>, Pb<sup>4+</sup>  
NH<sub>4</sub><sup>+</sup>  
Cd<sup>2+</sup>  
Zn<sup>2+</sup>  
Ni<sup>2+</sup>, Ni<sup>4+</sup>  
Au<sup>+</sup>, Au<sup>3+</sup>  
Co<sup>2+</sup>, Co<sup>3+</sup>  
Sn<sup>2+</sup>, Sn<sup>4+</sup>  
Cr<sup>2+</sup>, Cr<sup>3+</sup>

#### 4. Common Monatomic Anions

<u>Name</u>	<u>Symbol</u>	<u>Name</u>	<u>Symbol</u>	<u>Name</u>	<u>Symbol</u>
Hydride	H <sup>-</sup>	Iodide	I <sup>-</sup>	Telluride	Te <sup>2-</sup>
Fluoride	F <sup>-</sup>	Oxide	O <sup>2-</sup>	Nitride	N <sup>3-</sup>
Chloride	Cl <sup>-</sup>	Sulfide	S <sup>2-</sup>	Phosphide	P <sup>3-</sup>
Bromide	Br <sup>-</sup>	Selenide	Se <sup>2-</sup>	Arsenide	As <sup>3-</sup>

#### 5. Common Polyatomic Anions (two or more atoms)

<u>Name</u>	<u>Formula</u>	<u>Name</u>	<u>Formula</u>	<u>Name</u>	<u>Formula</u>
Nitrate	NO <sub>3</sub> <sup>-</sup>	Sulfate	SO <sub>4</sub> <sup>2-</sup>	Nitrite	NO <sub>2</sub> <sup>-</sup>
Permanganate	MnO <sub>4</sub> <sup>-</sup>	Carbonate	CO <sub>3</sub> <sup>2-</sup>	Dichromate	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>
Hydroxide	OH <sup>-</sup>	Chromate	CrO <sub>4</sub> <sup>2-</sup>	Sulfite	SO <sub>3</sub> <sup>2-</sup>
Cyanide	CN <sup>-</sup>	Phosphate	PO <sub>4</sub> <sup>3-</sup>	Chlorite	ClO <sub>2</sub> <sup>-</sup>
Perchlorate	ClO <sub>4</sub> <sup>-</sup>	Peroxide	O <sub>2</sub> <sup>2-</sup>	Hypochlorite	ClO <sup>-</sup>
Thiocyanate	SCN <sup>-</sup>	Chlorate	ClO <sub>3</sub> <sup>-</sup>	Acetate	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>
Bicarbonate	HCO <sub>3</sub> <sup>-</sup>	Bisulfate	HSO <sub>4</sub> <sup>-</sup>	Arsenate	AsO <sub>4</sub> <sup>3-</sup>
Oxalate	C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	Bromate	BrO <sub>3</sub> <sup>-</sup>	Formate	HCO <sub>2</sub> <sup>-</sup>

#### 6. Acids

Sulfuric	H <sub>2</sub> SO <sub>4</sub>	Perchloric	HClO <sub>4</sub>	Hydrocyanic	HCN
Phosphoric	H <sub>3</sub> PO <sub>4</sub>	Chloric	HClO <sub>3</sub>	Chlorous	HClO <sub>2</sub>
Nitric	HNO <sub>3</sub>	Hydrobromic	HBr	Hypochlorous	HClO
Hydrochloric	HCl	Hydroiodic	HI	Nitrous	HNO <sub>2</sub>

#### 7. Bases

Lithium hydroxide	LiOH	Magnesium hydroxide	Mg(OH) <sub>2</sub>
Sodium hydroxide	NaOH	Calcium hydroxide	Ca(OH) <sub>2</sub>
Potassium hydroxide	KOH	Strontium hydroxide	Sr(OH) <sub>2</sub>
Cesium hydroxide	CsOH	Ammonia	NH <sub>3</sub>
Rubidium hydroxide	RbOH		

There are four main classes of inorganic compounds we will learn how to name:

1. Compounds made from single valence metals.
2. Compounds made from multivalent metals.
3. Compounds containing only nonmetallic elements.
4. Acids (next semester)

# NOMENCLATURE RULES

Nomenclature is a set or system of names. The nomenclature that is used in chemistry is based on the IUPAC (International Union of Pure and Applied Chemists) convention. The basic rule is that the name of a particular compound must be completely unambiguous – that is, one name means one particular compound and no other. The simplified rules that follow can be used to name the majority of inorganic compounds.

## RULES FOR NOMENCLATURE OF SIMPLE COMPOUNDS

### RULE 1

The names of ionic compounds are derived from the positive ions (cation, usually a metal) and the negative ions (anion, non metal) in the compound.

For nonionic compounds (covalent/ molecular), consider the compound to be composed of 2 parts, one positive and one negative.

### RULE 2

The positive ion or part is always named first and written first in formulas. The basic rule: if an element is to the left of another element in the periodic table or below it, it is always less electronegative and named or written first.

### RULE 3

#### BINARY COMPOUNDS (2 ELEMENTS ONLY)

- (a) Positive element with a fixed oxidation state (metal or hydrogen):
- |                          |   |                                   |
|--------------------------|---|-----------------------------------|
| Cation                   |   | Anion                             |
| Name of positive element | + | “negative stem” with –ide suffix. |
- e.g.  $\text{CaCl}_2$       calcium chloride
- (b) Positive element with a variable oxidation state (metal): **STOCK SYSTEM** where the oxidation number of a metal( usually a transition metal) is specified with a Roman numeral in parenthesis and the negative ion is named as in (a) above.
- OLD METHOD stem name of metal (usually Latin) with the –ic indicating higher oxidation number and –ous the lower.
- |      |                 |                      |    |                  |
|------|-----------------|----------------------|----|------------------|
| e.g. | $\text{CuCl}$   | copper (I) chloride  | or | cuprous chloride |
|      | $\text{CuCl}_2$ | copper (II) chloride | or | cupric chloride  |

- (c) **TWO NONMETALS:** named as illustrated in (a) with prefixes to indicate how many of each element is present. **EXCEPTION:** if the first element consists of only one atom, the prefix for it is assumed (leave out -mono).

e.g.      CO                      carbon monoxide  
              N<sub>2</sub>O<sub>3</sub>                  dinitrogen trioxide

mono-	1 (omitted if no other prefixes are used)
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

- (d) In general, the -ide ending means binary compounds.

**EXCEPTIONS:**

NH <sub>4</sub> Cl	ammonium chloride (ammonium salts)
Mg(OH) <sub>2</sub>	magnesium hydroxide (metal hydroxides)
CuCN	copper (I) cyanide (metal cyanides)

- (e) **Binary Acids:** i.e. hydrogen plus a nonmetal

In gas phase, named as in (a):

HCl (g)	hydrogen chloride
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In water solution:      hydro (prefix) + negative stem + -ic acid

HCl (aq)	hydrochloric acid
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**RULE 4**

**OTHER COMPOUNDS:** compounds composed of three (or more) elements, most commonly a metal ion or hydrogen combined with a polyatomic ion (a non-metal, or occasionally a transition metal, combined with oxygen, as a general rule). Generally, it is best to memorize the polyatomic ions, along with their charges. With a few exceptions, all end in -ate or -ite. Compounds composed of metals plus these polyatomic ions are named as in (a) or (b) above, except that the name of the polyatomic ion is used in place of the nonmetallic ion. (The names and formulas of various polyatomic ions are given on your "Oxidation Numbers of Some Common Ions Sheet" sheet.

e.g.              NaC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>                      sodium acetate  
                     Cu(BrO<sub>3</sub>)<sub>2</sub>                      copper (II) bromate      or cupric bromate  
                     Ni(NO<sub>3</sub>)<sub>3</sub>                      nickel (III) nitrate  
                     (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>                      ammonium sulfate

When the polyatomic ion is combined with hydrogen, the compound is named as an acid by changing the –ate suffix to –ic or an –ite ending to –ous and adding the word acid to the name.

e.g.                       $\text{HC}_2\text{H}_3\text{O}_2$                       acetic acid  
                               $\text{HBrO}_3$                       bromic acid  
                               $\text{HNO}_2$                       nitrous acid

## Warm up

Compound	Cation	Anion	Formula
calcium phosphate			
potassium nitrate			
ammonium sulfate			
aluminum hydroxide			
rubidium peroxide			
lithium hydride			
calcium nitride			
ammonium nitrate			
nickel(III) sulfate			
barium nitrite			
chromium(II) phosphate			
			$\text{BPO}_3$
			$\text{Ba}(\text{ClO}_2)_2$
			$\text{CsC}_2\text{H}_3\text{O}_2$
			$\text{Si}(\text{MnO}_4)_4$
			$\text{K}_3\text{AsO}_4$

**REPORT SHEET  
NOMENCLATURE WORKSHEET**

**METALLIC COMPOUNDS**

- |                                       |                              |
|---------------------------------------|------------------------------|
| 1. _____ chromium (III) chloride      | 2. _____ gallium phosphate   |
| 3. _____ copper (I) sulfate           | 4. _____ barium acetate      |
| 5. _____ strontium hydrogen carbonate | 6. _____ calcium nitride     |
| 7. _____ potassium chromate           | 8. _____ magnesium carbonate |
| 9. _____ strontium dichromate         | 10. _____ ammonium phosphate |

- |           |   |
|-----------|---|
| 11. _____ | $\text{Al}_2(\text{SO}_4)_3$                  |
| 12. _____ | $\text{AuCl}_3$                               |
| 13. _____ | $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ |
| 14. _____ | $\text{K}_3\text{AsO}_4$                      |
| 15. _____ | $\text{CuSO}_3$                               |
| 16. _____ | $\text{Cs}_2\text{HPO}_4$                     |
| 17. _____ | $\text{Zn}(\text{BrO}_3)_2$                   |
| 18. _____ | $(\text{NH}_4)_2\text{CO}_3$                  |
| 19. _____ | $\text{BeSO}_4$                               |
| 20. _____ | $\text{FeO}$                                  |

**NONMETALLIC COMPOUNDS**

- |                                |                         |
|--------------------------------|-------------------------|
| 21. _____ $\text{PBr}_3$       | 22. _____ $\text{CF}_4$ |
| 23. _____ $\text{SO}_3$        | 24. _____ $\text{CO}_2$ |
| 25. _____ $\text{N}_2\text{O}$ | 26. _____ $\text{IF}_5$ |

27. \_\_\_\_\_  $\text{SbCl}_3$       28. \_\_\_\_\_  $\text{SiO}_2$   
29. \_\_\_\_\_  $\text{BrF}_5$       30. \_\_\_\_\_  $\text{SiC}$
31. \_\_\_\_\_ tetraphosphorus decoxide      32. \_\_\_\_\_ diarsenic trioxide  
33. \_\_\_\_\_ carbon tetrachloride      34. \_\_\_\_\_ carbon monoxide  
35. \_\_\_\_\_ phosphorus pentabromide      36. \_\_\_\_\_ bromine dioxide  
37. \_\_\_\_\_ carbon monosulfide      38. \_\_\_\_\_ phosphorus pentachloride  
39. \_\_\_\_\_ dinitrogen tetroxide      40. \_\_\_\_\_ tellurium dioxide

### MIXED REVIEW

41. \_\_\_\_\_ tin (IV) oxide      42. \_\_\_\_\_ zinc permanganate  
43. \_\_\_\_\_ ammonium hydroxide      44. \_\_\_\_\_ silver nitrate  
45. \_\_\_\_\_ iron (II) dichromate      46. \_\_\_\_\_ silver bicarbonate  
47. \_\_\_\_\_ hydrogen formate      48. \_\_\_\_\_ nitrogen triiodide  
49. \_\_\_\_\_ boron trifluoride      50. \_\_\_\_\_ hydrocyanic acid  
51. \_\_\_\_\_ sulfuric acid      52. \_\_\_\_\_  $\text{Au}_3(\text{PO}_4)_2$   
53. \_\_\_\_\_  $\text{CuHSO}_4$       54. \_\_\_\_\_  $\text{BI}_3$   
55. \_\_\_\_\_  $\text{FeCl}_3$

### MORE MIXED REVIEW

56. \_\_\_\_\_  $\text{FeAsO}_4$       57. \_\_\_\_\_ Arsenous acid  
58. \_\_\_\_\_ copper (II) oxalate      59. \_\_\_\_\_ potassium iodate  
60. \_\_\_\_\_ ammonium dichromate      61. \_\_\_\_\_ magnesium peroxide  
62. \_\_\_\_\_ gold (II) cyanide      63. \_\_\_\_\_ potassium hydroxide

64. \_\_\_\_\_ lead (IV) oxide      65. \_\_\_\_\_ tungsten (IV) oxide
66. \_\_\_\_\_ palladium (II) cyanide      67. \_\_\_\_\_  $\text{BF}_3$
68. \_\_\_\_\_  $\text{NH}_4\text{I}$       69. \_\_\_\_\_  $\text{CoCl}_3$
70. \_\_\_\_\_  $\text{NO}_3$       71. \_\_\_\_\_  $\text{FeAsO}_3$
72. \_\_\_\_\_ mercury (II) cyanide      73. \_\_\_\_\_  $\text{HBrO}_2$
74. \_\_\_\_\_  $\text{HClO}_3$       75. \_\_\_\_\_ lead (II) acetate